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UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Marketing Service
Fruit and Vegetable Division
Processed Products Standardization and Inspection Branch
Washington, D. C.

TECHNICAL

INSPECTION PROCEDURES

DETERMINATION OF FRUIT -- SUGAR RATIO

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FROZEN FRUITS

FOR USE OF USDA PROCESSED FOODS INSPECTORS

APRIL 1960

ACTION BY:	All Processed Foods Inspectors
APPROVED BY:	F. L. Southerland, Chief of the Branch
FILE UNDER:	Technical Inspection Procedures - FROZEN
THESE INSTRUCTIONS SUPERSEDE:	Inspectors Instructions for Frozen Fruits and Vegetables - Part II - Frozen Fruits - Determination of Fruit-Sugar Ratio
	or
	Proportion of Fruit to Liquid Packing Media dated May, 1956

TECHNICAL INSPECTION PROCEDURES
DETERMINATION OF FRUIT-SUGAR RATIO
FROZEN FRUITS

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INSPECTORS' INSTRUCTIONS FOR DETERMINATION OF FRUIT-SUGAR RATIO OR PROPORTION OF FRUIT TO LIQUID PACKING MEDIA

APRIL 1960

I GENERAL

The fruit and sugar content of frozen fruits and berries is not a requirement of the United States Standards other than that the product shall have been packed in accordance with good commercial practice and must conform to provisions of the Federal Food, Drug, and Cosmetic Act with respect to labeling.

Substantial quantities of frozen fruits, particularly in bulk containers, are used for manufacture into preserves, fruit pies, and related products. In the case of preserves and jellies, it is essential that the user know the exact fruit content (or proportion of fruit to packing media) in order to adjust formula to meet mandatory Food and Drug Standards of Identity which require a minimum of 45 parts of fruit ingredient (exclusive of added sweeteners) to each 55 parts of sugar solids. In the case of products not covered by mandatory standards, it is also important that the user have reasonable assurance as to the fruit content of the frozen fruit ingredient inasmuch as the quality of the finished product and the economic aspects of his operation are dependent to a large extent upon the quality of the fruit delivered by the processor.

There is no reliable method or procedure for checking the exact fruit content by restricting examination of finished product only. However, certain observations, tests and analyses may be performed that serve to verify the indicated or declared ratio of fruit to packing media. While these tests have a measure of diagnostic value, conclusions based solely on finished product testing depend upon the degree to which the in-going fruit conforms to average values for the various constituents in question as well as the integrity of the packer in observing good commercial practice during processing.

The most reliable and effective means of determining the proportion of fruit to packing media is by observations and checks during the packing of the fresh fruit to be sure that the fruit or berries when washed are well drained and that fruit and packing media are mixed in the proportions as declared or represented by the packer.

Even though the fruit content of frozen fruits is not a requirement of the United States Standards, many buyers include a stipulation with respect to proportion of fruit to sugar as a part of the contract specification. Frequently this is based upon the Brix value of the finished

product. Some packers make routine checks of the soluble solids of the fresh fruit and the finished product and some packers make periodic checks on the actual weight of sugar used in relation to the weight of the finished product. These checks may serve as a guide to the packer but do not necessarily offer any assurance to the recipient of the merchandise that the fruit-sugar ration is as declared or represented.

USDA inspection certificates which quote the label declaration with respect to fruit-sugar ratios are frequently misinterpreted by the trade in assuming that the USDA inspector made adequate checks to positively certify the fruit-sugar ratio. Moreover, the presence of a USDA inspector in a plant during the packing operation is frequently understood as assurance that sufficient checks are being made to be sure that the finished product complies with the label declaration and that the product is packed in accordance with good commercial practice.

Even though the applicant may not wish a certification of proportion of fruit to packing media, it is nevertheless imperative that inspectors assigned to plants make sufficient observations to be sure that the fruit is properly drained and that there is no unreasonable deviation in compliance with the declared or indicated fruit-sugar ratio.

Berries and fruits are packed with varying amount of added sugar, ranging from a "straight pack" with no added sugar to what is known as 7 x 1, 6 x 1, 5 x 1, 4 x 1, 3 x 1, etc., the first number indicating the proportion of fruit and the latter number the proportion of sugar. Some fruits are also packed with a liquid sweetened packing medium and may be labeled to indicate the proportion of fruit to liquid media - "5 parts fruit 1 part 60 degrees syrup."

To further illustrate - a 3 x 1 pack means 3 parts by weight of fruit and 1 part by weight of dry sugar. Unless otherwise specified, these ratios are understood as meaning a dry sweetener rather than a liquid packing medium and sucrose rather than other sweeteners. Assuming the merchandise is accurately labeled or represented, the buyer or receiver can readily ascertain the weight of fruit ingredient and the weight of sugar in a given container or lot.

For example - the proportion of ingredients in a 400-pound barrel of frozen berries packed with different declared proportions of fruit and sugar is calculated as follows.

(1) If declared as 5 x 1 (5 parts fruit 1 part sugar), then 5/6 of the contents is fruit and 1/6 is sugar.

Fruit = (5/6) (400) or 333 1/3 pounds
Sugar = (1/6) (400) or 66 2/3 pounds

(2) If declared as 3 x 1 (3 parts fruit 1 part sugar), then 3/4 of the contents is fruit and 1/4 is sugar.

Fruit = (3/4) (400) or 300 pounds
Sugar = (1/4) (400) or 100 pounds

(3) If declared as 4 parts fruit and 1 part 60 degrees syrup then 4/5 of the contents is fruit and 1/5 is packing medium.

Fruit = (4/5) (400) or 320 pounds
Syrup = (1/5) (400) or 80 pounds

The amount of added sugar in the packing media is readily calculated as follows:

60 degrees Brix syrup means 60 percent sugar solids.

(80) (0.60) = 48 pounds of sugar solids and the remaining 32 pounds is water derived from the liquid packing medium.

In the foregoing examples, assuming that either additional sugar or added water (or both) have been added, the product no longer conforms to the label declaration and theoretical calculation of fruit ingredient would be misleading and unreliable.

II VERIFICATION OF FRUIT-SUGAR RATIO DURING IN-PLANT INSPECTION

Direct observation of the processing operation affords the best means and most reliable method for determination of fruit-sugar ratios or proportion of fruit to liquid packing media. The inspector should use such methods or combination of methods that will best serve the purpose of ascertaining the fruit-sugar ratio. This will vary depending upon the plant processing procedures.

These checks and observations may consist of the following:

(1) Physical check of the amount of fruit, sugar or packing media (or both) being packed into individual containers.

(2) Check of the amount of sugar used and number of containers packed over a given interval of time.

(3) Where (1) and (2) are not practical, verification of fruit content may be made on the basis of soluble solids of in-going fruit and the finished product, respectively.

IN ALL CASES IT IS IMPORTANT THAT THE INSPECTOR ASSURE HIMSELF THAT THE FRUIT OR BERRIES ARE PROPERLY DRAINED AFTER WASHING AND PRIOR TO MIXING WITH SUGAR.

Whenever possible, checks on proportion of fruit to packing media should be made by more than one method in order to obtain greater accuracy.

Inspection and certification should be based upon numerous determinations made during the shift or day because reasonable variations between individual containers are expected even under carefully controlled packing operations.

Correct procedure, together with illustrative examples, is outlined in detail in the following discussion:

A. Direct Measurement of Fruit or Packing Media in Individual Containers.

Not all plant operations readily lend themselves to a direct measurement of fruit ingredient or sugar. There are some plants, however, that weigh out a specific quantity of fruit in each container and then add a measured amount of sugar or syrup to make up the required net weight. In such instances, observe the operation at unannounced intervals and make periodic checks on the weighers. Be sure to deduct the weight of the container in calculating the amount of fruit added.

There may still be a limited number of plants in which the fruit is layered into the container together with sugar which is added by means of measured scoop, rather than by weight. In such instances, the sugar is generally received in 100 pound bags and dumped into a tub or vat located adjacent to the filler. The fruit-sugar ratio may be determined by counting the number of bags or sugar and the number of containers packed over a specified interval.

For example - over a 5-minute period, 400 pounds of sugar were used in packing 50 containers of fruit in 50 pound cans of a specified 5 x 1 ratio.

50 cans 50 pounds each = 2500 pounds finished product.
5 x 1 ratio means 5/6 fruit and 1/6 sugar.
(1/6) (2500) - 416 2/3 pounds of sugar.

Therefore, the packer is complying reasonably close to the declared ratio since the theoretical quantity of sugar needed is 416 2/3 pounds and he actually used slightly less, or 400 pounds.

In the case of fruit packed with a liquid packing media, the fruit content can best be determined by periodically checking containers prior to the addition of the syrup. Generally, the fruit is added to the container and then passed beneath a syruper which adds a measured quantity of syrup.

For example - if frozen raspberries are being packed in 10 pound cans to a declared ratio of 4 parts fruit and 1 part syrup, each container should have a put-in fruit weight of 8 pounds - (4/5 x 10).

B. Check on Amount of Sugar or Fruit Packed Over a Given Time Interval.

In instances whenever it is not practical to check the amount of sugar or fruit packed in individual containers, the inspector will have to rely upon the amount of sugar used during a given time interval.

Many plants use a mixer in which the sugar is metered from a hopper and blended with fruit in a continuous operation. The sugar hopper holds a measured amount of sugar and the rate of flow is controlled mechanically by manually adjusting the feed opening. The mixer may require periodic adjustment, even though the ratio is not changed, due to the effect of humidity, physical characteristics of the sugar, etc. Some mixers are so erratic that it is almost impossible to establish the ratio with any degree of reliability.

Knowing the quantity of sugar used for a given number of containers, the fruit-sugar ratio can be determined even though the weight of in-going berries is not known. The line need not be stopped to make the check. By allowing the sugar hopper to become almost empty, or by placing a mark in a specified location in the hopper, the number of bags or sugar required to reach the mark over an approximate 5 minute period of time is recorded, together with the number of containers of finished products packed during the interval. From this date the ratio can be determined.

For example - in a continuous operation packing a declared 3 x 1 fruit ratio in 30 pound cans, 1200 pounds of sugar were used for 150 cans.

Weight of finished product (150) (30) =	4500 pounds.
Weight of sugar	1200 pounds.
Weight of fruit	3300 pounds.

Therefore 3300 pounds fruit for 1200 pounds sugar.

$$R = \frac{3300}{1200} \text{ or } 2.75$$

In this instance, the product does not conform to the label declaration of 3 plus 1 as substantially more sugar is being used than declared.

Another means of checking the fruit-sugar ratio is to determine the actual quantity of sugar used during a shift or day and compare with the number of containers of product packed. If various ratios are being packed from the same sugar inventory, this procedure is not practical to follow. However, for a single ratio for a given lot it can be advantageously used to check the overall fruit-sugar ratio.

For example - a carload of frozen fruit is packed to a declared 4 x 1 ratio. 1600 containers of 30 pound each required 9500 pounds of sugar (95 - 100 pounds bags).

1600 containers 30 pounds each = 48,000 pounds.
Weight of fruit - 48,000 minus 9500 or 38,500 pounds.

$$\text{Fruit-sugar ratio} = \frac{38{,}500}{9{,}500} \text{ or } 4.05$$

In this instance, the ratio is only slightly higher than declared, actually represents a slight excess of fruit and should be considered satisfactory.

C Estimation Based on Soluble Solids

The use of soluble solids as a means of estimating the fruit-sugar ration is not as satisfactory or reliable as direct checks on the amount of fruit used in relation to sugar. However, when direct checks cannot be made on the exact weight of fruit and sugar used, the soluble solids method is probably the best alternative procedure.

The principal disadvantage of this method are as follows:

(1) Considerable variation in the proportion of the fruit and sugar can be expected from container to container. Therefore, numerous samples must be checked in determining fruit content.

(2) Any water adhering to the berries after washing will lower the Brix value of the finished product and thereby tends to distort the true fruit-sugar ratio; this lowered Brix value would tend to indicate that more fruit had been used whereas actually water has been substituted for fruit.

(3) The soluble solids of the fresh fruit may vary considerably and it is sometimes impractical to obtain a sample of the finished product that can be positively identified as having been packed from fruit of a specified soluble solids reading. However, unless the fresh fruit varies substantially during the packing period, this error is not significant.

Despite the aforementioned possible source of error, the ratio of fruit to sugar may be estimated with a reasonable degree of accuracy. The average of numerous samples taken at intervals during the day will tend to compensate for errors inherent in individual samples. Certainly unreasonable or marked deviations will be apparent in applying the procedure which follows:

(1) Obtain a representative one-pound sample of the fruit being processed. If the fruit or berries are washed, select the sample immediately prior to mixing with the sugar. Do not drain the sample any more than is accomplished in the processing procedure.

(2) At approximately the same time, obtain a sample of the finished product prior to freezing. The finished product sample should be selected and prepared as follows:

(a) If retail size containers, select a sufficient number simultaneously from the line in order to make an approximate 2 pound composite. For example -- 3 - 10 ounce cartons or 2 - 16 ounce cartons.

(b) If institution size (e.g. No. 10 can) thoroughly mix the entire container and select a representative 3 pound sub.

(c) If bulk containers, such as 30 pound cans or barrels, catch approximately 15 pounds from the filler, mix thoroughly and select a representative 3 pound sub.

(3) Place the sample (2) above, in a Waring Blender or other suitable mechanical mixer and comminute the product until it is thoroughly mixed and of a homogeneous character.

(4) Place the comminuted sample in a closed container and allow to equalize for about 30 minutes, stirring occasionally. The amount of time required for equalization may need be increased depending upon the product, type of sweetener and method of blending. This can be checked at each plant to determine the proper equalization period.

(5) Place a drop of the filtrate from the blended mixture (3) on the prism of a refractometer and determine the soluble solids using the Brix scale. Make any temperature corrections that are necessary. In obtaining the filtrate for the refractive index reading, the comminuted mixture may be filtered through a rapid filter paper or milk strainer disc.

(6) Determine the soluble solids of the fresh fruit or berries in a manner similar to that described for the finished product (3) and (4).

(7) Knowing the soluble solids of both the in-going fruit and the finished product, calculate the proportion of fruit to sugar as follows:

$$R = \frac{100 - Ps}{Ps - Fs}$$ in which

R = Ratio of fruit to sugar.

Ps = Soluble solids of finished product (fruit plus sugar).

Fs = Soluble solids of in-going fruit.

For example - the soluble solids of fresh peaches is 12.2. The soluble solids of the finished product (peaches plus dry sugar) is 31.8.

The fruit-sugar ratio is calculated as follows:

$$R = \frac{100 - 31.8}{31.8 - 12.2}$$

$$R = \frac{68.2}{19.6}$$

$$R = 3.48$$

If the product were labeled or specified as a 3.5 to 1 ratio, the actual proportion of fruit to sugar (3.48 to 1) is sufficiently close to consider as meeting requirements.

For the convenience of the inspector, tables have been developed and are included as part of this instruction to assist in the calculation of fruit-sugar ratios and finished product Brix values.

TABLE I -- "Ratio Parts of Fruit to One Part Sugar by Weight."

This table covers a range in the raw fruit from 0 to 12.5 degrees Brix and a finished product Brix value from 12.5 to 42.0 degrees. Knowing the Brix of the raw fruit and the Brix value of the finished product, the theoretical fruit-sugar ratio may quickly be ascertained. Or knowing the Brix of the raw fruit and the packer's declaration of fruit-sugar ratio, the ratio of fruit to sugar may be confirmed by comparing the theoretical Brix value of the finished product (top horizontal line on chart) with the actual Brix value of the finished product (as determined on the finished product by the inspector.

TABLE II through V -- may be used for quick reference to determine the theoretical Brix value of the finished product for specified fruit-sugar ratios of general commercial importance.

III ESTIMATION OF FRUIT-SUGAR RATIO BASED SOLELY ON FINISHED PRODUCT EXAMINATION

Determination of fruit content based solely upon examination of finished product is less reliable and involves much more detailed procedure than direct observation and check during packing operations. However, there are certain measurements, determinations, and analyses that may be performed on the finished product that may serve to substantiate the fruit content. These checks or determinations are:

(1) Soluble solids
(2) Drained Weights
(3) Chemical analyses (ash, water-insoluble solids, potash, phosphate and acidity).

Discretion must be exercised in the interpretation of the values obtained by any of these methods or tests since variations will be found naturally occurring in the fruit, in packing practice from plant to plant, and in the product itself within the same container, especially bulk sizes.

Since fruit-sugar ratio or proportion of fruit to liquid packing media based on examination of the finished product is not fully reliable, the inspector will not normally make these determinations on the finished product except (a) upon special request, and (b) in instances where an inspector is assigned to plants packing jams (preserves) he should make checks on the raw material to the fullest practical extent for fruit-sugar ratio or proportion of fruit to liquid packing media, when the history of the raw material is unknown to him. It may not be practical for him to make the chemical analysis at all. However, if material deficiencies are suspected, the inspector should contact his Washington office through his supervisor for advice.

The merits and limitations of each method is discussed herein in greater detail.

A Soluble Solids

If the frozen fruit pack is a mixture of fruit and dry sugar, the soluble solids as determined by refractometer affords a very simple and rapid method for estimation of fruit-sugar ratio. Assuming the berries reasonably close to the average authentic value for the respective fruit, and assuming the product has been packed in accordance with good commercial practice, this determination is probably the most reliable means of checking the fruit content of the finished product. The "authentic values" referred to in this section are derived from Food and Drug data prepared by the examination of numerous samples of the respective fruits or berries as summarized in the Journal of the AOAC, Vol. XXI, No. 3, dated August 1938.

The method consists of pulping the entire sample in a Waring Blender or other suitable laboratory mill and determining the soluble solids using the sucrose scale. The theoretical fruit-sugar ratio may be determined from the following formula:

$$R = \frac{100 - Ps}{Ps - Fs}$$ in which

R = Ratio of fruit to sugar.

R = Soluble solids of finished product.

R = Soluble solids of in-going fruit or average soluble solids of authentic fruit.

Generally, the average value for authentic fruit will necessarily be used in the formula since on lot inspections the inspector will not know the actual solids of the in-going fruit.

The following example will serve to illustrate the calculation for frozen strawberries:

Ps (soluble solids of product) = 28.4

Fs (soluble solids of authentic fruit = 8.0

R = $\frac{100 - 28.4}{}$

R = $\frac{71.6}{20.4}$ or 3.50

The same evaluation can be readily ascertained by referring to TABLE I, attached to this instruction.

Follow the horizontal line across the chart to the Brix value of the finished product (28.5 is closest value), follow this vertical column downward to the ratio opposite Brix of fruit value of 8.0. The value at the intersection of the two lines is the theoretical ratio. By referring to the table and interpolating to the nearest value shown in the table, a fruit Brix of 8.0 and a finished product Brix of 28.4 is 3.51.

The average authentic values for the most common fruits and berries are as follows: 1/

Apples	13.7
Apricots	14.4
Blackberries	10.0
Cherries	13.9
Crabapples	15.4
Currants	10.6
Figs	19.0
Gooseberries	8.2
Guayas	7.6
Loganberries	10.6
Grapes	14.1
Peaches	11.8
Pineapples	14.6
Plums	14.8
Raspberries (red)	10.5
Raspberries (black)	11.2
Strawberries	8.0

1/ See Journal of the AOAC, Vol. XXI, No. 3, dated August 1938.

The limitations and potential errors of using soluble solids as an estimation of fruit content are as follows:

(1) Entire contents of container must be macerated. In the case of bulk containers this is not only time consuming but involves destruction of the product.

(2) When using average authentic values, considerable error may be introduced if the fresh fruit from which the product is prepared deviates materially from the authentic values.

(3) Improper draining of washed fruit or addition of water materially affects the ratio. This is a very significant factor and must be carefully checked during In-Plant inspection. The significance of excess water can be readily shown by the following examples:

(a) Assume a processor is packing strawberries to a declared ratio of 4 plus x, that the strawberries have a soluble solids of 8.0 percent, and that for each 100 pounds of finished product, 8 pounds of water are added through improper draining.

(b) For each 100 pounds there will be 72 pounds of berries, 8 pounds of water, and 20 pounds of dry sugar.

(c) The theoretical solids of the finished product of a 4 plus 1 ratio should be 26.4.

(d) The actual solids of the example illustrated may be calculated as follows:

72 pounds fruit (8 percent solids)	5.76 pounds
8 pounds water (no solids)	0.0
20 pounds of sugar (100 percent solids)	20.00
Finished product solids	25.76

(4) Referring to Table I the theoretical value for 25.76 and a fruit of 8 percent solids is 4.2. Therefore, it would appear from the soluble solids values that the packer is a little generous with the fruit whereas actually he has substituted 8 pounds of water for an equal weight of fruit.

The economic advantage of selling water at the same price as frozen strawberries is readily apparent. Therefore, it is very important that inspectors use whatever means are available in checking the adequacy of draining of frozen fruits and berries.

B. Drained Weights

Because of the many variables affecting drained weight, this determination cannot generally be relied upon as an indication of the actual fruit ingredient present. However, when considered together with other checks and measurements, they may provide supporting data for the estimated fruit-sugar ratios.

The most serious limitation of drained weight as a criteria of fruit content are as follows:

(1) Certain fruits (for example, sliced strawberries) tend to break down during thawing and leach out readily before the weight is actually taken.

(2) Large containers are difficult to thaw under a standardized procedure and in some instances (as barrels) almost impractical to drain.

(3) Methods of freezing and time interval between packing and freezing may materially affect drained weight.

(4) Method of thawing containers and draining must be carefully standardized.

(5) Excessive handling of containers prior to freezing affects the drained weight.

(6) Reliable data on authentic packs of different container sizes for the respective fruit must be available for comparison.

Despite the disadvantages of basing fruit content on drained weight only, some progress has been made in this field.

For example - the United States Department of Agriculture has developed and published a method for determining the drained weight of frozen RSP cherries in large containers.

As a result of this study, it was found that the drained weight of 30 pound containers varied considerably between processing areas, between individual packers and was noticeably affected by the distance the fruit was hauled between packing and freezing. Under ideal conditions with a very short haul for freezing. Under ideal conditions with a very short haul for freezing, the drained weight represented a maximum of 70 percent of the put-in weight of actual fruit. Identical packs, after being hauled long distances for freezing, dropped as low as 60 percent of actual put-in weight. In other producing areas, using the same technique, it was impossible to attain the same drained weights - they being as much as 10 percent lower. Despite these variations, knowing the packing conditions, time interval between packing and freezing, distance hauled, the inspector could predict with a fair degree of accuracy the put-in weight of fruit based on actual drained weight data.

Similarly, the Food and Drug Administration has devoted considerable effort toward the development of a method for drained weight of retail size containers of fruits. The procedure is outlined in the AOAC and involves thawing in water under carefully controlled conditions. Based on Food and Drug data for retail-sized packages (16 ounces and less) an estimate may be made of the amount of fruit ingredient using drained weight values. The percent of drained weight in relation to in-going weight of fruit is as follows:

Strawberries	66 percent
Red Raspberries	75 percent
RSP Cherries	88 percent
Peaches	80 percent
Apricots	83 percent
Blackberries	88 percent

The put-in weight of fruit may be estimated by multiplying the drained weights by 100, and dividing by the value shown in the foregoing tabulation for the respective fruit. For example - 1 12 ounce carton of frozen red raspberries having a drained weight of 8 ounces would have an estimated put-in weight of fruit of:

$$\frac{(8)\ (100}{75} \quad \text{or} \quad 10\ 2/3 \text{ ounces.}$$

or

a 16 ounce carton of frozen strawberries with a put-in weight of only 9 ounces should drain out to approximately (2/3) (9) or 6 ounces.

Chemical Analyses

Chemical analyses of the finished product has been frequently used to estimate the amount of fruit ingredient, sugar, and water in frozen fruits and berries. Despite the wealth of data available on the various constituents in fruits, this method has definite limitations and is impractical as an inspection procedure.

The basic objections to this method are:

(1) Detailed examination and analyses is time consuming, requires special laboratory equipment and good technique.

(2) Conclusions drawn are dependent upon accuracy of analyses, the interpretation applied to the results of such analyses, and the representation of the samples examined.

(3) Normal variation in fruits are frequently so extreme that considerable latitude has to be used in application of formula for estimation of fruit content.

The method essentially consists of a comparison of the results of the analyses with similar data of authentic fruits for such constituents as water-insoluble solids, potash (K(2)0), phosphate (P(2)05), acidity, etc. Numerous determinations on lots from specific areas and specific packers may serve to establish a trend toward a deficiency of fruit ingredient. However, as previously stated, the time involved in making the checks and the many factors to consider make this method undesirable for general use by the Branch.

IV SUMMARY OF PERTINENT ASPECTS RELATING TO DETERMINATION OF FRUIT-SUGAR RATIOS

In order to offer reasonable protection and assurance to the purchaser (in many instances a preserver who must comply with Food and Drug legal requirements with respect to fruit ingredient in preserves and jellies) that the product packed conforms to the declared fruit-sugar ratio, there are certain checks which the inspector must periodically make during packing operations under In-Plant inspection. It is recognized that all of these checks are difficult to apply to each and every operation. Nevertheless, adequate checks must be made in order that the product is not misrepresented with respect to fruit-sugar ratio. Also, the recipients of inspection certificates too often assume that USDA inspectors, when assigned to plants, are maintaining checks on declared fruit-sugar ratios. Therefore, it is necessary that the inspection certificate clearly indicate the fruit-sugar ratio of lots which are declared, labeled, or represented as being of a specified fruit-sugar ratio. When such determinations are not made, the inspection certificate should state that the fruit-sugar ratio was not determined.

The type of check and procedure to follow will necessarily vary depending upon the packing operations. However, as many determinations and observations as are applicable and feasible should be applied to each operation. These checks are summarized as follows:

(1) Be sure the fruit and berries are adequately drained after washing.

(2) If a liquid packing medium is being added, check the actual weight of fruit in numerous containers prior to the addition of syrup. Determine the proportion of fruit to syrup based on weight of fruit in relation to the weight of entire contents of finished product.

(3) If dry sugar is being used and the fruit and sugar are being weighed separately, check the accuracy of the scales or metering devices by periodic observations of the weighing operation and also by physically weighing the amount of each product being dispensed by such devices.

(4) If the fruit is being mixed with dry sugar in a continuous mixer, check the number of containers packed out from a given number of bags or other measured quantity of sugar over a reasonable time interval. Determine the average fruit-sugar ratio based on number of containers packed and quantity of sugar used.

(5) Whenever possible, verify compliance with declared or specified fruit-sugar ratio by ascertaining the number of containers packed during a day, shift, or period, and the total quantity of sugar used for the period under observation. This will be an average value for the entire quantity packed during the period even though there may be variation between individual containers.

(6) When direct measurements of fruit and sugar cannot be made, check the ratio by determining the soluble solids of both the in-going fruit prior to adding sugar and the finished product. Observe the steps out-lined in this instruction in using this procedure to determine fruit-sugar ratio.

TABLE I: RATIO PARTS OF FRUIT TO ONE PART SUGAR BY WEIGHT

BRIX OF SWEETENED PRODUCT

BRIX OF FRUIT	12.5	13.0	13.5	14.0	14.5	15.0	15.5	16.0	16.5	17.0	17.5	18.0	18.5	19.0	19.5	20.0	20.5	21.0	21.5	22.0	22.5	23.0	23.5	24.0	24.5	25.0	25.5	26.0	26.5	27.0
0.0	7.00	6.69	6.41	6.14	5.90	5.67	5.45	5.25	5.06	4.88	4.71	4.56	4.41	4.26	4.13	4.00	3.88	3.76	3.65	3.55	3.44	3.35	3.26	3.17	3.08	3.00	2.92	2.85	2.77	2.70
0.5	7.29	6.96	6.65	6.37	6.11	5.86	5.63	5.42	5.22	5.03	4.85	4.69	4.53	4.38	4.24	4.10	3.96	3.85	3.74	3.63	3.52	3.42	3.33	3.23	3.15	3.06	2.98	2.90	2.83	2.75
1.0	7.61	7.25	6.92	6.62	6.33	6.07	5.83	5.60	5.39	5.19	5.00	4.82	4.66	4.50	4.35	4.21	4.08	3.95	3.83	3.71	3.60	3.50	3.40	3.30	3.21	3.13	3.04	2.96	2.88	2.81
1.5	7.95	7.57	7.21	6.88	6.58	6.30	6.04	5.79	5.57	5.35	5.16	4.97	4.79	4.63	4.47	4.32	4.18	4.05	3.93	3.80	3.69	3.58	3.48	3.38	3.28	3.19	3.10	3.02	2.94	2.86
2.0	8.33	7.91	7.52	7.17	6.84	6.54	6.26	6.00	5.76	5.53	5.32	5.13	4.94	4.78	4.60	4.44	4.30	4.16	4.03	3.90	3.78	3.67	3.56	3.45	3.36	3.26	3.17	3.08	3.00	2.92
2.5	8.75	8.29	7.86	7.48	7.13	6.80	6.50	6.22	5.96	5.72	5.50	5.29	5.09	4.91	4.74	4.57	4.42	4.27	4.13	4.00	3.88	3.76	3.64	3.53	3.43	3.33	3.24	3.15	3.06	2.98
3.0	9.21	8.70	8.24	7.82	7.43	7.08	6.76	6.46	6.19	5.93	5.69	5.47	5.26	5.06	4.88	4.71	4.54	4.39	4.24	4.11	3.97	3.85	3.73	3.62	3.51	3.41	3.31	3.22	3.13	3.04
3.5	9.72	9.16	8.65	8.19	7.77	7.39	7.04	6.72	6.42	6.15	5.89	5.66	5.43	5.23	5.03	4.85	4.68	4.51	4.38	4.22	4.08	3.95	3.83	3.71	3.60	3.49	3.39	3.29	3.20	3.11
4.0	10.29	9.67	9.11	8.60	8.14	7.73	7.35	7.00	6.68	6.38	6.11	5.86	5.62	5.40	5.19	5.00	4.82	4.85	4.49	4.33	4.19	4.05	3.92	3.80	3.68	3.57	3.47	3.38	3.27	3.17
4.5		10.24	9.61	9.05	8.55	8.10	7.68	7.30	6.96	6.64	6.35	6.07	5.82	5.59	5.37	5.16	4.97	4.79	4.62	4.46	4.31	4.16	4.03	3.90	3.78	3.86	3.55	3.44	3.34	3.24
5.0			10.18	9.56	9.00	8.50	8.05	7.64	7.26	6.92	6.60	6.31	6.04	5.79	5.55	5.33	5.13	4.94	4.76	4.59	4.43	4.28	4.14	4.00	3.87	3.75	3.63	3.58	3.42	3.32
5.5				10.12	9.50	8.95	8.45	8.00	7.59	7.22	6.88	6.56	6.27	6.00	5.75	5.52	5.30	5.10	4.91	4.73	4.56	4.40	4.25	4.11	3.97	3.85	3.73	3.61	3.50	3.40
6.0					10.06	9.44	8.89	8.40	7.95	7.55	7.17	6.83	6.52	6.23	5.96	5.71	5.48	5.27	5.08	4.88	4.70	4.53	4.37	4.22	4.08	3.95	3.82	3.70	3.59	3.48
6.5						10.00	9.39	8.84	8.35	7.90	7.50	7.13	6.79	6.48	6.19	5.93	5.68	5.45	5.23	5.03	4.84	4.67	4.50	4.34	4.19	4.05	3.92	3.79	3.68	3.56
7.0							9.94	9.33	8.79	8.30	7.86	7.45	7.00	6.75	6.44	6.15	5.89	5.64	5.41	5.20	5.00	4.81	4.64	4.47	4.31	4.17	4.03	3.89	3.77	3.65
7.5							10.56	9.88	9.28	8.74	8.35	7.81	7.41	7.04	6.71	6.40	6.12	5.85	5.61	5.38	5.17	4.78	4.61	4.44	4.29	4.14	4.00	4.00	3.87	3.74
8.0								10.50	9.82	9.22	8.68	8.20	7.76	7.36	7.00	6.67	6.36	6.08	5.81	5.57	5.34	5.13	4.94	4.75	4.58	4.41	4.26	4.11	3.97	3.84
8.5									10.44	9.78	9.17	8.63	8.15	7.71	7.32	6.96	6.63	6.32	6.04	5.78	5.54	5.31	5.10	4.90	4.72	4.55	4.38	4.23	4.08	3.95
9.0										10.39	9.71	9.11	8.58	8.10	7.67	7.27	6.91	6.58	6.28	6.00	5.74	5.50	5.28	5.07	4.87	4.69	4.52	4.35	4.20	4.06
9.5											10.31	9.65	9.06	8.53	8.05	7.62	7.23	6.87	6.54	6.24	5.96	5.70	5.46	5.24	5.03	4.84	4.66	4.48	4.32	4.17
10.0												10.25	9.59	9.00	8.47	8.00	7.57	7.18	6.83	6.50	6.20	5.92	5.87	5.43	5.21	5.00	4.81	4.63	4.45	4.29
10.5													10.19	9.53	8.94	8.42	7.957.	7.52	7.14	6.78	6.46	6.16	5.88	5.63	5.39	5.17	4.97	4.77	4.59	4.42
11.0														10.13	9.47	8.89	8.37	7.90	7.48	7.09	6.74	6.42	6.12	5.85	5.59	5.36	5.14	4.93	4.74	4.58
															10.06	9.41	8.83	8.32	7.85	7.43	7.05	6.70	6.38	6.08	5.81	5.56	5.32	5.10	4.90	4.71
																10.00	9.35	8.78	8.26	7.80	7.38	7.00	6.65	6.33	6.04	5.77	5.52	5.29	5.07	4.87
																	9.94	9.29	8.72	8.21	7.75	7.33	6.95	6.61	6.29	6.00	5.73	5.48	5.25	5.03

(CONTINUED)

TABLE I: RATIO PARTS OF FRUIT TO ONE PART SUGAR BY WEIGHT

BRIX OF FRUIT	BRIX OF SWEETENED PRODUCT																													
	27.5	28.0	28.5	29.0	29.5	30.0	30.5	31.0	31.5	32.0	32.5	33.0	33.5	34.0	34.5	35.0	35.5	36.0	36.5	37.0	37.5	38.0	38.5	39.0	39.5	40.0	40.5	41.0	41.5	42.0
0.0	2.64	2.57	2.51	2.45	2.39	2.33	2.28	2.23	2.17	2.13	2.08	2.00	1.99	1.94	1.90	1.86	1.82	1.78	1.74	1.70	1.67	1.63	1.60	1.56	1.53	1.50	1.47	1.44	1.41	1.38
0.5	2.69	2.62	2.55	2.49	2.43	2.37	2.32	2.26	2.21	2.16	2.11	2.06	2.02	1.97	1.93	1.88	1.84	1.80	1.78	1.73	1.69	1.65	1.62	1.58	1.55	1.52	1.49	1.40	1.43	1.40
1.0	2.74	2.67	2.60	2.54	2.47	2.41	2.36	2.30	2.25	2.19	2.14	2.09	2.05	2.00	1.96	1.91	1.87	1.83	1.79	1.75	1.71	1.68	1.64	1.61	1.57	1.54	1.51	1.48	1.44	1.41
1.5	2.79	2.72	2.65	2.58	2.52	2.46	2.40	2.34	2.28	2.23	2.18	2.13	2.08	2.03	1.98	1.94	1.90	1.86	1.81	1.77	1.74	1.70	1.66	1.63	1.59	1.56	1.53	1.49	1.46	1.43
2.0	2.84	2.77	2.70	2.63	2.56	2.50	2.44	2.38	2.32	2.27	2.21	2.16	2.11	2.06	2.02	1.97	1.93	1.88	1.84	1.80	1.76	1.72	1.68	1.65	1.61	1.58	1.55	1.51	1.48	1.45
2.5	2.90	2.82	2.75	2.68	2.61	2.55	2.48	2.42	2.36	2.31	2.25	2.20	2.15	2.10	2.05	2.00	1.95	1.91	1.87	1.83	1.79	1.75	1.71	1.67	1.64	1.60	1.57	1.53	1.50	1.47
3.0	2.96	2.88	2.80	2.73	2.66	2.59	2.53	2.46	2.40	2.34	2.29	2.23	2.18	2.13	2.08	2.03	1.98	1.94	1.90	1.85	1.81	1.77	1.73	1.69	1.66	1.62	1.59	1.55	1.52	1.49
3.5	3.02	2.94	2.86	2.78	2.71	2.64	2.57	2.51	2.45	2.39	2.33	2.27	2.22	2.16	2.11	2.06	2.02	1.97	1.92	1.88	1.84	1.80	1.76	1.72	1.68	1.64	1.61	1.57	1.54	1.51
4.0	3.09	3.00	2.92	2.84	2.76	2.69	2.62	2.56	2.49	2.43	2.37	2.31	2.25	2.20	2.15	2.10	2.05	2.00	1.95	1.91	1.87	1.82	1.78	1.74	1.70	1.67	1.63	1.59	1.56	1.53
4.5	3.15	3.06	2.98	2.90	2.82	2.75	2.67	2.60	2.54	2.47	2.41	2.35	2.29	2.24	2.18	2.13	2.08	2.03	1.98	1.94	1.89	1.85	1.81	1.77	1.73	1.69	1.65	1.62	1.58	1.55
5.0	3.22	3.13	3.04	2.96	2.88	2.80	2.73	2.65	2.58	2.52	2.45	2.39	2.33	2.28	2.22	2.17	2.11	2.06	2.02	1.97	1.92	1.88	1.84	1.79	1.75	1.71	1.68	1.64	1.60	1.57
5.5	3.30	3.20	3.11	3.02	2.94	2.86	2.78	2.71	2.63	2.57	2.50	2.44	2.38	2.32	2.26	2.20	2.15	2.10	2.05	2.00	1.95	1.91	1.86	1.82	1.78	1.74	1.70	1.66	1.63	1.59
6.0	3.37	3.27	3.18	3.09	3.00	2.92	2.84	2.76	2.69	2.62	2.55	2.48	2.42	2.38	2.30	2.24	2.19	2.13	2.08	2.03	1.98	1.94	1.89	1.85	1.81	1.78	1.72	1.69	1.65	1.61
6.5	3.45	3.35	3.25	3.16	3.07	2.98	2.90	2.82	2.74	2.67	2.60	2.53	2.46	2.40	2.34	2.28	2.22	2.17	2.12	2.07	2.02	1.97	1.92	1.85	1.83	1.79	1.75	1.71	1.67	1.63
7.0	3.54	3.49	3.33	3.23	3.13	3.04	2.96	2.88	2.80	2.72	2.65	2.58	2.51	2.44	2.38	2.32	2.26	2.21	2.15	2.10	2.05	2.00	1.95	1.91	1.86	1.82	1.78	1.74	1.70	1.66
7.5	3.63	3.51	3.40	3.30	3.20	3.11	3.02	2.94	2.85	2.78	2.70	2.63	2.56	2.49	2.43	2.36	2.30	2.25	2.19	2.14	2.08	2.03	1.98	1.94	1.89	1.85	1.80	1.78	1.72	1.68
8.0	3.72	3.60	3.49	3.38	3.28	3.18	3.09	3.00	2.91	2.83	2.76	2.66	2.61	2.54	2.47	2.41	2.35	2.29	2.22	2.17	2.12	2.07	2.02	1.97	1.92	1.88	1.83	1.79	1.75	1.71
8.5	3.82	3.69	3.58	3.46	3.36	3.26	3.18	3.07	2.98	2.89	2.81	2.73	2.66	2.59	2.52	2.45	2.39	2.33	2.27	2.21	2.16	2.10	2.05	2.00	195	1.90	1.86	1.82	1.77	1.73
9.0	3.92	3.79	3.67	3.55	3.44	3.33	3.23	3.14	3.04	2.96	2.87	2.79	2.71	2.64	2.57	2.50	2.43	2.37	2.31	2.25	2.19	2.14	2.06	2.03	1.98	1.94	1.89	1.84	1.80	1.76
9.5	4.03	3.89	3.76	3.64	3.53	3.41	3.31	3.21	3.11	3.02	2.93	2.85	2.77	2.69	2.62	2.55	2.48	2.42	2.35	2.29	2.23	2.18	2.12	2.07	2.02	1.97	1.92	1.87	1.83	1.78
10.0	4.14	4.00	3.86	3.74	3.62	3.50	3.39	3.29	3.19	3.09	3.00	2.91	2.83	2.75	2.67	2.60	2.53	2.46	2.40	2.33	2.27	2.21	2.16	2.10	2.05	2.00	1.95	1.90	1.86	1.81
10.5	4.26	4.11	3.97	3.84	3.71	3.59	3.48	3.37	3.28	3.16	3.07	2.98	2.89	2.81	2.73	2.65	2.56	2.51	2.44	2.38	2.31	2.25	2.20	2.14	2.09	2.03	1.98	1.93	1.89	1.84
11.0	4.39	4.24	4.09	3.94	3.81	3.68	3.56	3.45	3.34	3.24	3.14	3.05	2.96	2.87	2.79	2.71	2.63	2.56	2.49	2.42	2.36	2.30	2.24	2.18	2.12	2.07	2.02	1.97	1.92	1.87
11.5	4.53	4.36	4.21	4.06	3.92	3.78	3.66	3.54	3.43	3.32	3.21	3.12	3.02	2.93	2.85	2.77	2.69	2.61	2.54	2.47	2.40	2.34	2.28	2.22	2.16	2.11	2.05	2.00	1.95	1.90
12.0	4.68	4.50	4.33	4.18	4.03	3.89	3.76	3.63	3.51	3.40	3.29	3.19	3.09	3.00	2.91	2.83	2.74	2.67	2.59	2.52	2.45	2.38	2.32	2.28	2.20	2.14	2.09	2.03	1.98	1.93

12.5	4.83	4.65	4.47	4.30	4.15	4.00	3.86	3.73	3.61	3.49	3.38	3.27	3.17	3.07	2.98	2.89	2.80	2.72	2.65	2.58	2.50	2.43	2.37	2.30	2.24	2.18	2.13	2.07	2.02	1.97

TABLE II

REFRACTOMETER READINGS AT 20 DEGREES C ON PRODUCT AS A FUNCTION OF SUGAR CONTENT OF FRUIT FOR A 3 PLUS 1 PACK			
0	25.0	6.5	29.9
.5	25.4	7.0	30.3
1.0	25.8	7.5	30.6
1.5	26.1	8.0	31.0
2.0	26.5	8.5	31.4
2.5	26.9	9.0	31.8
3.0	27.3	9.5	21.1
3.5	27.6	10.0	32.5
4.0	28.0	10.5	32.9
4.5	28.4	11.0	33.3
5.0	28.8	11.5	33.5
5.5	29.1	12.0	34.0
6.0	29.5	12.5	34.4

TABLE 111

REFRACTOMETER READINGS AT 20 DEGREES C ON PRODUCT AS A FUNCTION OF SUGAR CONTENT OF FRUIT FOR A 4 PLUS 1 PACK			
0	20.0	6.5	25.2
.5	20.4	7.0	25.6
1.0	20.8	7.5	26.0
1.5	21.2	8.0	26.4
2.0	21.6	8.5	26.8
2.5	22.0	9.0	27.2
3.0	22.4	9.5	27.6
3.5	22.8	10.0	28.0
4.0	23.2	10.5	28.4
4.5	23.6	11.0	28.8
5.0	24.0	11.5	29.2
5.5	24.4	12.0	29.6
6.0	24.8	12.5	30.0

TABLE IV

REFRACTOMETER READINGS AT 20 DEGREES C ON PRODUCT AS A FUNCTION OF SUGAR CONTENT OF FRUIT FOR A 5 PLUS 1 PACK			
0	16.7	6.5	22.1
.5	17.1	7.0	22.5
1.0	17.5	7.5	22.9
1.5	17.9	8.0	23.3
2.0	18.3	8.5	23.8
2.5	18.8	9.0	24.2
3.0	19.2	9.5	24.6
3.5	19.6	10.0	25.0
4.0	20.0	10.5	25.4
4.5	20.4	11.0	25.8
5.0	20.8	11.5	26.3
5.5	21.3	12.0	26.7
6.0	21.7	12.5	27.1

TABLE V

REFRACTOMETER READINGS AT 20 DEGREES C ON PRODUCT AS A FUNCTION OF SUGAR CONTENT OF FRUIT FOR A 7 PLUS 1 PACK			
0	12.5	6.5	18.2
.5	12.9	7.0	18.6
1.0	13.4	7.5	19.1
1.5	13.8	8.0	19.5
2.0	14.3	8.5	19.9
2.5	14.7	9.0	20.4
3.0	15.1	9.5	20.8
3.5	15.6	10.0	21.3
4.0	16.0	10.5	21.7
4.5	16.4	11.0	22.1
5.0	16.9	11.5	22.6
5.5	17.3	12.0	23.0
6.0	17.8	12.5	23.4